CHEMICAL AND BIOLOGICAL ENGINEERING (CBE)

CBE 1 — COOPERATIVE EDUCATION PROGRAM
1 credit.

Work experience which combines classroom theory with practical knowledge of operations to provide students with a background upon which to base a professional career.

Requisites: So st
Course Designation: Workplace - Workplace Experience Course
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE 250 — PROCESS SYNTHESIS
3 credits.

An introduction to the invention of processes for the large scale, low cost processing of materials such as water, chemicals, petroleum products, food, drugs and wastes. Open to students in any field.

Requisites: CHEM 329 or CHEM 343 or concurrent registration
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 255 — INTRODUCTION TO CHEMICAL PROCESS MODELING
3 credits.

Introduction to modeling of chemical processes and introduction to using modern computational tools to analyze the models.

Requisites: MATH 319 or 320 or con reg
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 310 — CHEMICAL PROCESS THERMODYNAMICS
3 credits.

Introduction to thermodynamics, energy balances, applications to steady state and unsteady state processes, behavior of pure fluids, chemical reaction equilibria.

Requisites: MATH 234, PHYSICS 201 or equiv; CBE 255 or equiv or con reg; CBE 250 with a grade of C or better
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 311 — THERMODYNAMICS OF MIXTURES
3 credits.

Properties of ideal and non-ideal vapors and liquids, ideal and non-ideal multicomponent vapor-liquid and liquid-liquid equilibria, complex chemical reaction equilibria, electrolytic solutions, surface thermodynamics, solid phase thermodynamics.

Requisites: CBE 310 with a grade of C or better
Repeatable for Credit: No
Last Taught: Fall 2017

CBE/B M E 320 — INTRODUCTORY TRANSPORT PHENOMENA
4 credits.

Mass, momentum, and energy transport; calculation of transport coefficients; solution to problems in viscous flow, heat conduction, and diffusion; dimensional analysis; mass, momentum, and heat transfer coefficients; over-all balances; elementary applications.

Requisites: PHYSICS 201, MATH 319 or 320, CBE 250 with grade of C or better; or consent of instructor
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 324 — TRANSPORT PHENOMENA LAB
3 credits.

Determination of thermodynamic properties, transport properties, and transfer coefficients; study of related phenomena.

Requisites: CBE 310 320, or concurrent registration; STAT 324
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 326 — MOMENTUM AND HEAT TRANSFER OPERATIONS
3 credits.

Analysis of chemical engineering operations involving fluid flow and heat transfer. Flow of fluids through ducts and porous media; motion of particulate matter in fluids; general design and operation of fluid-flow equipment. Conductive, convective and radiative heat exchange with and without phase change; general design and operation of heat-exchange equipment.

Requisites: CBE 310 320 with grades of C or better
Repeatable for Credit: No
Last Taught: Fall 2017

CBE/B M E 330 — ENGINEERING PRINCIPLES OF MOLECULES, CELLS, AND TISSUES
3 credits.

Introduction to the fundamental principles of kinetics and transport that are relevant for the analysis of biological systems. Topics covered include concepts of reaction rate, stoichiometry, equilibrium, momentum/mass transport, and the interaction between transport and kinetics in biological systems.

Requisites: (E M A 201 or PHYSICS 201 or 207) and (MATH 319 or MATH 320) and (CHEM 104 or 109)
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 361 — BIOMOLECULAR ENGINEERING LABORATORY
3 credits.

Instruction and laboratory experiments in basic molecular biology techniques, recombinant protein production, fermentation processes, protein purification and characterization, and related bioengineering laboratory topics. Geared towards chemical engineering students with interests in biotechnology and synthetic biology.

Requisites: CBE 250; Zoo 151 or 153 or equivalent; or consent of instructor
Repeatable for Credit: No
Last Taught: Spring 2017
CBE 424 — OPERATIONS AND PROCESS LABORATORY
5 credits.

Experiments in unit operations, and supervised individual assignments
selected from areas such as: fluid dynamics, analytical methods, reaction
kinetics, plastics technology, and use of computers in data processing
and simulation.
Requisites: CBE 324, 326, 426 430; or consent of instructor
Course Designation: Gen Ed - Communication Part B
Repeatable for Credit: No
Last Taught: Summer 2017

CBE/CHM/E M A/M E 425 — UNDERGRADUATE RHEOLOGY SEMINAR
1 credit.

Rheology seminar course encouraged for all interested in professions
related to polymers, suspensions or rheology; will not count toward credit
requirement of the major.
Requisites: Junior standing
Course Designation: Level - Advanced
L&S Credit: Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2011

CBE 426 — MASS TRANSFER OPERATIONS
3 credits.

Analysis of chemical engineering operations involving mass transfer.
Differential and stagewise separation processes; simultaneous heat and
mass transfer accompanied by chemical reaction; general
design and operation of mass-transfer equipment.
Requisites: CBE 311 320 with grades of C or better, or consent of
instructor
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 430 — CHEMICAL KINETICS AND REACTOR DESIGN
3 credits.

Analysis and interpretation of kinetic data and catalytic phenomena;
application of basic engineering principles to chemical reactor design.
Requisites: CBE 311 320; or consent of instructor
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 440 — CHEMICAL ENGINEERING MATERIALS
3 credits.

Structure and properties of metallic and nonmetallic materials of
construction; interrelations between chemical bonding, structure, and
behavior of materials.
Requisites: CHEM 345
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 450 — PROCESS DESIGN
3 credits.

Analysis and design of chemical processing systems and equipment.
Requisites: CBE 326, 426 430 or consent of instructor
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 470 — PROCESS DYNAMICS AND CONTROL
3 credits.

A systematic introduction to dynamic behavior and automatic control
of industrial processes; lab includes instrumentation, measurement and
control of process variables by using conventional hardware and real-time
digital computers.
Requisites: CBE 326; CBE 430 or concurrent registration
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 489 — HONORS IN RESEARCH
1-3 credits.

Undergraduate honors research projects supervised by faculty members.
Requisites: Admission to CBE honors in research prgm
Course Designation: Honors - Honors Only Courses (H)
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE/CHM 505 — ASPECTS OF INDUSTRIAL CHEMISTRY AND
BUSINESS FUNDAMENTALS
3 credits.

The objective of this course is to educate students in the chemistry
and chemical engineering that defines societies' standard of living.
Commercial chemical processes will be reviewed. Practical realities of
how a discovery moves from research to commercial product will be
taught through examples and case studies. Financial concepts that guide
investment will be reviewed.
Requisites: Junior standing and CHEM 345
Course Designation: Level - Advanced
L&S Credit: Counts as Liberal Arts and Science credit in L&S
Repeatable for Credit: No
Last Taught: Spring 2016

CBE/B M E 510 — INTRODUCTION TO TISSUE ENGINEERING
3 credits.

Overview of tissue engineering, including discussion of cell sources,
cell-material interactions, tailoring biomaterials, methods of culture and
characterization of engineering tissues, ethical issues, concluding with
case studies of specific types of tissue engineering. Optional laboratory
exercises offered throughout semester.
Requisites: BME 430 or equiv, or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework
requirement
Repeatable for Credit: No
Last Taught: Fall 2017

CBE/B M E/BSE 517 — BIOLOGY IN ENGINEERING SEMINAR
1 credit.

Current topics at the interface of biology and engineering with special
emphasis on the ways in which engineers have contributed to knowledge
and advances in biology.
Requisites: Jr st in engr one college-level biol crse
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017
CBE/B M E 520 — STEM CELL BIOENGINEERING
3 credits.
Covers engineering approaches that are used to understand and manipulate stem cells. Concepts covered include: introduction to stem cell biology, quantitative modeling of stem cell signaling, methods to engineer the stem cell microenvironment, and the role of stem cells in tissue development and regeneration.
Requisites: MATH 319 or 320, ZOOLOGY 470 or 570, CHEM 343, or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

CBE/M E 525 — MACROMOLECULAR HYDRODYNAMICS
3 credits.
Requisites: CBE/B M E 320 or ME 363 or equivalent or consent of instructor
Repeatable for Credit: No
Last Taught: Spring 2015

CBE 535 — HETEROGENEOUS CATALYSIS: PRINCIPLES AND APPLICATIONS
3 credits.
This course discusses catalytic phenomena, with extensions to reactor design and catalyst characterization. Examples will be drawn from current problems in catalysis.
Requisites: CBE 430 or cons inst
Repeatable for Credit: No
Last Taught: Spring 2017

CBE 540 — POLYMER SCIENCE AND TECHNOLOGY
3 credits.
Synthesis, properties, and fabrication of plastic materials of industrial importance.
Requisites: CHEM 345; CBE 326 430, or concurrent registration; STAT 324; or consent of instructor
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 541 — PLASTICS AND HIGH POLYMER LABORATORY
1-3 credits.
Experiments on polymerization, fabrication, and testing of plastics.
Requisites: CBE 540 or concurrent registration; or CHEM 664 or concurrent registration
Repeatable for Credit: No
Last Taught: Spring 2015

CBE/E C E/M S & E 544 — PROCESSING OF ELECTRONIC MATERIALS
3 credits.
Physics and chemistry principles underlying microelectronic materials processing. Effects of processing on materials and structures important in microelectronic and opto-electronic devices.
Requisites: CBE 440 or MSE 351 or ECE 335, or cons inst
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2009

CBE 547 — INTRODUCTION TO COLLOID AND INTERFACE SCIENCE
3 credits.
Introduction to topics in colloid and interface science. Topics include: sedimentation and diffusion, solution thermodynamics, rheology, light scattering, surface tension and contact angle, adsorption, association colloids, particle interactions, electrodynamics, and colloidal stability.
Requisites: CHEM 561 or 562 or equiv, or cons inst
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 555 — SEMINAR-CHEMICAL ENGINEERING CONNECTIONS
1 credit.
Considers a variety of current engineering applications and problems. Students will investigate background information on topics of their choice, and present seminars to describe how engineering fundamentals interact with societal impact and how our undergraduate education in chemical engineering is relevant to societal concerns at large.
Requisites: Sr st or cons inst
Repeatable for Credit: No
Last Taught: Fall 2017

CBE/B M E 560 — BIOCHEMICAL ENGINEERING
3 credits.
Properties of biological molecules; enzyme kinetics, enzyme reactors, and enzyme engineering; metabolic engineering; microbial growth kinetics; bioreactor design; bioseparations.
Requisites: CBE 310; CBE/B M E 320; Zoo 151 or 153; or consent of instructor
Repeatable for Credit: No
Last Taught: Fall 2017

CBE 562 — SPECIAL TOPICS IN CHEMICAL ENGINEERING
1-3 credits.
Topics of specialized interest to majors in chemical engineering. Given on demand.
Requisites: Jr st and cons inst
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE/M E 567 — SOLAR ENERGY TECHNOLOGY
3 credits.
Radiant energy transfer and its application to solar exchangers; energy balances for solar exchangers, review of theory, economics, and practice of solar energy applications.
Requisites: ME 364 or CBE 326 or consent of instructor
Repeatable for Credit: No
Last Taught: Fall 2017
CBE 575 — INSTRUMENTAL ANALYSIS FOR CHEMICAL ENGINEERS  
3 credits.  
Instrumental methods as applied to chemical and physical processes in chemical engineering. Spectroscopic, optical, and electrochemical methods; chromatography, differential thermal analysis, and microscopy.  
Requisites: CBE 324 or consent of instructor  
Repeatable for Credit: No  
Last Taught: Spring 2017

CBE 599 — SPECIAL PROBLEMS  
1-4 credits.  
Research or independent study.  
Requisites: Consent of instructor  
Course Designation: Level - Advanced  
L&S Credit - Counts as Liberal Arts and Science credit in L&S  
Repeatable for Credit: Yes, unlimited number of completions  
Last Taught: Fall 2017

CBE 620 — INTERMEDIATE TRANSPORT PHENOMENA  
3 credits.  
Mass, momentum, and energy transport; kinetic theory of transport properties; analytical and approximate solutions to the equations of change; boundary layer theory; turbulence; simultaneous heat and mass transfer; multiphase component diffusion.  
Requisites: Grad standing in CBE or consent of instructor  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: No  
Last Taught: Spring 2017

CBE 660 — INTERMEDIATE PROBLEMS IN CHEMICAL ENGINEERING  
3 credits.  
Illustrations of solving chemical engineering problems by using a variety of mathematical topics such as ordinary and partial differential equations, Laplace transform, Bessel functions, matrices, and tensor analysis. Problem formulation and interpretation of results emphasized.  
Requisites: Grad st in CBE or cons inst  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: No  
Last Taught: Fall 2017

CBE 660 — ADVANCED INDEPENDENT STUDIES  
1-5 credits.  
Research on assigned topics.  
Requisites: Consent of instructor  
Course Designation: Level - Advanced  
L&S Credit - Counts as Liberal Arts and Science credit in L&S  
Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: Yes, unlimited number of completions  
Last Taught: Fall 2017

CBE 702 — GRADUATE COOPERATIVE EDUCATION PROGRAM  
1-2 credits.  
Work experience that combines classroom theory with practical knowledge of operations to provide students with a background on which to develop and enhance a professional career. The work experience is tailored for MS students from within the U.S. as well as eligible international students.  
Requisites: Graduate or professional standing  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Last Taught: Summer 2017

CBE 710 — ADVANCED CHEMICAL ENGINEERING THERMODYNAMICS  
3 credits.  
Application of thermodynamic principles to selected topics, including equations of state, non-ideal solutions, and complex physical and chemical equilibria.  
Requisites: Grad st in CBE or cons inst  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: No  
Last Taught: Fall 2017

CBE 720 — PHYSICOCHEMICAL HYDRODYNAMICS  
3 credits.  
Tensor analysis; partial differential equations for multi-component fluid mixtures; applications to laminar flow, turbulent flow, porous media, particulate systems; two-phase flow problems; interfacial transport; boundary-layer methods and variational procedures.  
Requisites: CBE 620 660, or cons inst  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: No  
Last Taught: Spring 2016

CBE 731 — COMPUTATIONAL MODELLING OF REACTIVE SYSTEMS  
3 credits.  
Requisites: Grad st in CBE or cons inst  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: No  
Last Taught: Spring 2010

CBE 735 — KINETICS AND CATALYSIS  
2-3 credits.  
Survey of kinetic principles and factors which influence reaction rates, with particular emphasis on catalysts and catalytic reactions. May include a seminar on modern catalytic research.  
Requisites: Grad st in CBE or cons inst  
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement  
Repeatable for Credit: No  
Last Taught: Fall 2017
CBE 747 — ADVANCED COLLOID AND INTERFACE SCIENCE
3 credits.

Advanced topics in colloid and interface science. Topics include: intermolecular forces, stability of thin films, association colloids, liquid crystals, microhydrodynamics, electrostatics, electrokinetics, colloidal stability, and dispersion rheology.

Requisites: CBE 547 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2015

CBE 750 — ADVANCED CHEMICAL PROCESS SYNTHESIS AND OPTIMIZATION
3 credits.

Methodologies for synthesis and optimization of chemical process systems. Application of linear, nonlinear, and mixed integer programming to steady state process optimization, production planning, and flowsheet synthesis.

Requisites: Graduate standing in CBE or consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2016

CBE 770 — ADVANCED PROCESS DYNAMICS AND CONTROL
3 credits.

Modern methods for the mathematical analysis and control of dynamical systems. Application to physico-chemical systems. Real-time computer control.

Requisites: Grad st in CBE or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

CBE/ECE/MATH 777 — NONLINEAR DYNAMICS, BIFURCATIONS AND CHAOS
3 credits.

Advanced interdisciplinary introduction to qualitative and geometric methods for dissipative nonlinear dynamical systems. Local bifurcations of ordinary differential equations and maps. Chaotic attractors, horseshoes and detection of chaos.

Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

CBE 781 — BIOLOGICAL ENGINEERING: MOLECULES, CELLS & SYSTEMS
3 credits.

Protein engineering and protein-protein interactions, receptor-ligand binding, cell metabolism and signaling, metabolic engineering and synthetic biology, tissue engineering. Additional topics may be covered such as: regenerative medicine, biomaterials, microbe-host interactions.

Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Fall 2017

CBE/BME 782 — MODELING BIOLOGICAL SYSTEMS
3 credits.

Literature survey of mathematical models in biology at the molecular and cellular levels; application of chemical kinetics and thermodynamics to biological systems; comparison of deterministic and stochastic strategies.

Requisites: MATH 319 or 320 or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2015

CBE/BME 783 — DESIGN OF BIOLOGICAL MOLECULES
3 credits.

Introduction to the methodologies for engineering the structure and function of biological molecules, especially proteins. Students will develop an understanding for the integration of computation and experiment to address biological molecular engineering problems.

Requisites: Biocore 303 or BIOCHEM 501 or ZOOLOGY 570; or cons inst
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: No
Last Taught: Spring 2017

CBE 790 — MASTER'S RESEARCH OR THESIS
1-9 credits.

Requisites: Grad st, for Master's candidates only
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE 890 — PRE-DISSERTATOR'S RESEARCH
1-9 credits.

Requisites: Grad st, for post-master’s, pre-dissertator stdts only
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017
CBE/B M E/B M I/BIOCHEM/COMP SCI/GENETICS 915 — COMPUTATION AND INFORMATICS IN BIOLOGY AND MEDICINE
1 credit.
Participants and outside speakers will discuss current research in computation and informatics in biology and medicine. This seminar is required of all CIBM program trainees.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE 920 — SEMINAR ON ADVANCES IN TRANSPORT PHENOMENA
1 credit.
Critical review of recent and current research in transport phenomena and allied disciplines.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2013

CBE/CHEM/E M A/M E 925 — RHEOLOGY RESEARCH SEMINAR
1 credit.
Exploration of the most recent research literature on viscoelasticity, constitutive equations, non-Newtonian flow systems, fluid metering devices, kinetic theory of macromolecules, and rheooptical phenomena. Periodic reports on recent advances made by research workers in the various rheology groups on the Madison campus.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2011

CBE/BIOCHEM/MICROBIO 932 — BIOTECHNOLOGY TRAINING PROGRAM SEMINAR
1 credit.
Biotechnology Training Program trainees will present their research for critical review by audience. Required of Biotechnology Training Program trainees
Requisites: Grad st.
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE 970 — SEMINAR ON PROCESS ANALYSIS, SYNTHESIS, DYNAMICS AND CONTROL
1 credit.
Critical review of recent and current research in these areas.
Requisites: Graduate or professional standing
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 2016

CBE 990 — THESIS-RESEARCH
1-12 credits.
Requisites: Dissertator status
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Fall 2017

CBE 999 — ADVANCED INDEPENDENT STUDIES
1-6 credits.
Requisites: Consent of instructor
Course Designation: Grad 50% - Counts toward 50% graduate coursework requirement
Repeatable for Credit: Yes, unlimited number of completions
Last Taught: Spring 1997